General

Guideline Title

ACR Appropriateness Criteria® radiographically detected solitary pulmonary nodule.

Bibliographic Source(s)

Kanne JP, Jensen LE, Mohammed TH, Kirsch J, Amorosa JK, Brown K, Chung JH, Dyer DS, Ginsburg ME, Heitkamp DE, Kazerooni EA, Ketai LH, Parker JA, Ravenel JG, Saleh AG, Shah RD, Expert Panel on Thoracic Imaging. ACR Appropriateness CriteriaÂ® radiographically detected solitary pulmonary nodule. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 6 p. [39 references]

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Khan A, Lee TJ, Mohammed TL, Batra PV, Gurney JW, Haramati LB, Jeudy J, MacMahon H, Rozenshtein A, Vydareny KH, Washington L, Kaiser L, Raoof S, Expert Panel on Thoracic Imaging. ACR Appropriateness Criteria® solitary pulmonary nodule. [online publication]. Reston (VA): American College of Radiology (ACR); 2008. 5 p.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Radiographically Detected Solitary Pulmonary Nodule

Variant 1: Solid nodule ≥1 cm, low clinical suspicion for cancer.

Radiologic Procedure	Rating	Comments	RRL*
CT chest without contrast	8	To detect occult calcifications, fat, bronchus sign, etc.	
CT chest with contrast	4	Inappropriate on HRCT.	
CT chest without and with contrast	4	Inappropriate on HRCT.	
CT whole body	1		

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level

Radiologic Procedure	Rating	Comments	RRL*
Transthoracic needle biopsy	8	If nodule shows contrast enhancement or PET scan is positive.	Varies
CT chest with contrast	6	Probably not indicated if PET performed.	
CT chest without and with contrast	6	Can look at washout.	
Watchful waiting with CT follow-up	4	Reasonable at short interval.	Varies
MRI chest without contrast	2	Limited data.	O
MRI chest without and with contrast	2	Limited data.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate.			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Solid nodule ≥1 cm, moderate to high clinical suspicion for cancer.

Radiologic Procedure	Rating	Comments	RRL*
CT chest without contrast	8	To detect occult calcifications, fat, bronchus sign, etc.	
FDG-PET/CT whole body	8	If nodule is indeterminate on HRCT.	
Transthoracic needle biopsy	8	If nodule shows contrast enhancement or PET scan is positive.	Varies
CT chest with contrast	6	Probably not indicated if PET performed.	
CT chest without and with contrast	6	Can look at washout.	
Watchful waiting with CT follow-up	2		Varies
MRI chest without contrast	2	Limited data.	O
MRI chest without and with contrast	2	Limited data.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Solid nodule <1 cm, low clinical suspicion for cancer.

Radiologic Procedure	Rating	Comments	RRL*
Watchful waiting with CT follow-up	8		Varies
CT chest without contrast	7		
CT chest without and with contrast	5	Depends on size (washout study).	
CT chest with contrast	3		
FDG-PET/CT whole body	3		
Transthoracic needle biopsy	2		Varies
MRI chest without contrast	2	Limited data.	O
MRI chest without and with contrast	2	Limited data.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Solid nodule <1 cm, moderate to high clinical suspicion for cancer.

Radiologic Procedure	Rating	Comments	RRL*
CT chest without contrast	8		
Transthoracic needle biopsy	6		Varies
Watchful waiting with CT follow-up	5		Varies
CT chest without and with contrast	5	Depends on size (washout study).	
CT chest with contrast	4		
FDG-PET/CT whole body	2		

Radiologic Procedure	Rating	Comments	RRL*
MRI chest without contrast	2	Limited data.	O
MRI chest without and with contrast	2	Limited data.	O
Rating Scale:1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

The solitary pulmonary nodule is defined as a rounded opacity ≤3 cm in diameter surrounded by lung parenchyma. There should be no associated abnormality, including atelectasis or hilar lymphadenopathy. This definition is based on information obtained from the chest radiograph. On computed tomography (CT), nodules are described as being solid, semisolid (mixed attenuation), or ground-glass attenuation. Pure ground-glass attenuation nodules are areas of increased lung attenuation through which normal structures such as vessels or septa remain discernible.

The incidence of solitary nodules detected by chest radiography was previously estimated to be approximately 150,000 per year in the United States. However, this figure did not include the multitude of smaller nodules detected with CT. When these are included, the incidence of pulmonary nodules in the general population dramatically increases, though precise estimates are not available. Although what constitutes a small nodule is not formally established, nodules with diameters <1 cm are generally considered small. As with radiographically detected nodules, the primary aim in evaluating these smaller nodules is the ability to confirm or exclude malignancy.

Although pulmonary nodules have been studied for decades, there are few reliable characteristics to distinguish benign from malignant nodules. The only findings sufficient to preclude further evaluation are a benign pattern of calcification or stability of nodule size for over 2 years for solid pulmonary nodules. Both of these criteria have been known since the early 1950s. Recently, the radiologic-pathologic correlation of pure ground-glass attenuation nodules and mixed attenuation nodules with the histologic spectrum of pulmonary adenocarcinoma has been described. While not all ground-glass attenuation nodules are malignant, they are more likely to be multiple and may demonstrate an indolent growth pattern, rendering 2-year stability inadequate to establish benignity. The likelihood of malignancy increases with nodule size, which may influence management strategy. Other nodule features such as shape, edge characteristics, cavitation, and location have not yet been found to be accurate clues for distinguishing benign from malignant nodules. As a result, the majority of nodules are indeterminate.

Overview of Diagnostic Tests

A host of diagnostic tests are available to evaluate patients with solitary pulmonary nodules. It should be noted that for all of these tests, the accuracy tends to decrease with smaller nodule size. Diagnostic tests range from noninvasive decision-theoretic approaches to major surgery. It is often the role of the radiologist to suggest an appropriate management strategy.

Theoretic approaches for decision-making include the use of Bayes theorem, logistic regression models, and neural network analysis. These approaches are useful primarily in estimating the probability of malignancy for a particular nodule. Information from the radiologic appearance of the nodule such as size, shape, and edge characteristics can be combined with clinical risk information such as age and smoking history to produce an overall probability for malignancy. If this probability can be set sufficiently low, strategies that include observing nodules for interval change can be advocated. These estimates can be combined with subsequent imaging information to further define the probability of malignancy and guide additional steps in the diagnostic workup.

Extensive work is now being done using advanced image processing techniques to further evaluate nodule attributes and change over time. One area of investigation includes the ability to use 3-dimensional nodule characteristics. Volumetric analysis measures growth of nodules in short time intervals, allowing for assessment of doubling time, a biologic measure of tumor aggressiveness. Changes in nodule morphology and attenuation are also being assessed. Factors that affect the reproducibility of nodule volume measurement on CT include nodule size at detection, examination technique, nodule relationship to adjacent structures, underlying lung disease, and patient factors such as phase of respiration and cardiac motion.

Computer-aided detection (CAD) systems have been developed for lung nodule detection on CT. CAD has the potential to improve radiologists' diagnostic confidence in detection and accuracy in distinguishing small benign nodules from malignant ones on high-resolution CT (HRCT). At this point, studies have shown that CAD information can be helpful in clinical practice by providing radiologists a "second opinion."

Computed Tomography

Contrast-enhanced CT of solitary pulmonary nodules has also been used to distinguish benign from malignant nodules. Results from a large multicenter study found that contrast-enhanced CT has a sensitivity of 98% and a specificity of 58% when using a cutoff of 15 Hounsfield units for enhancement. This led the authors to conclude that absence of enhancement is a strong predictor of benignity. An analysis of combined wash-in and washout characteristics at dynamic contrast-enhanced multidetector CT showed 92% accuracy for distinguishing benign from malignant nodules. The extent of enhancement reflects underlying nodule angiogenesis. Limitations of the technique relate to its nonspecific nature for inflammatory disease and measurement error in evaluation of small nodules. Dual-energy CT imaging has also been used in several studies to evaluate nodules with similar diagnostic accuracy. Through postprocessing techniques, contrast-enhanced and virtual-noncontrast images are generated from a single acquisition, which may reduce patient radiation dose.

Magnetic Resonance Imaging

Use of magnetic resonance imaging (MRI) in evaluation of pulmonary nodules has thus far been limited. Faster imaging sequences and techniques to mitigate artifact have allowed for detection of smaller nodules (6-10 mm) with sensitivity near 95%. For nodules >1 cm, contrast-enhanced dynamic MRI has shown to be comparable to CT for distinguishing benign from malignant nodules with a sensitivity of 96%, specificity of 88%, and accuracy of 92%. The possibility of a nonionizing assessment method for nodules is attractive, especially for younger patients. However, further research and validation are required to define a place for MR in clinical practice.

Positron Emission Tomography

Positron emission tomography (PET) using fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG) has assumed a major role in the evaluation of patients with solitary pulmonary nodules. This technique relies on measuring glucose metabolism, which has been shown to be different between benign and malignant nodules. Many studies have demonstrated the accuracy of FDG-PET in evaluating solitary pulmonary nodules. The sensitivity and specificity for this technique, as reported in the literature, have ranged from 83% to 97% and from 69% to 100%, respectively. FDG-PET has a higher specificity and only slightly reduced sensitivity compared to nodule-enhancement CT. Limitations of PET scanning include its inability to accurately characterize certain types of lesions, including low-grade adenocarcinoma and typical carcinoid tumors. It is also limited in its ability to characterize nodules <1 cm in diameter and it may give false-positive results in patients with active infections and inflammatory diseases.

Other Diagnostic Tests

The aggressive nature of lung cancer often compels the diagnostic evaluation to be near certainty, and consequently tests that provide pathologic material are quite useful. Currently, such diagnostic tests include transthoracic needle biopsy (TNB), bronchoscopy, video-assisted thoracoscopic surgery (VATS), and thoracotomy. The relative roles of these procedures are not well defined in existing literature, perhaps because of the lack of a defined sensitivity and specificity for the semi-invasive tests. Both TNB and bronchoscopy are highly dependent on nodule size and location and on the skill of the person performing the procedure. In general, TNB has a higher sensitivity and specificity than bronchoscopy, and therefore it is usually a more appropriate test in diagnosing solitary nodules. CT fluoroscopy-guided lung biopsy using an automated cutting needle provides a high degree of diagnostic accuracy, allows for the specific characterization of lung nodules, and can be performed safely with a sensitivity of 95.1%, specificity of 100%, and accuracy of 96.2%. The role of TNB relative to the surgical approach depends primarily on the ability to make a benign diagnosis. If the only role of TNB is to confirm malignancy, then it only adds to the cost of the overall workup, although there can be some use in confirming malignancy before surgery, such as diagnosing small-cell carcinoma. The diagnosis of benign disease using TNB is generally divided into three broad categories: specific benign diagnosis, nonspecific benign diagnosis, and nondiagnostic biopsy.

Recent reports suggest that the number of specific benign diagnoses can be increased using core needles, although this occurs at the cost of increasing complication rates when large-caliber needles are used. In general, for benign nonspecific and nondiagnostic studies, repeat biopsy or resection is necessary. Compared to thoracotomy, VATS offers the benefit of lower perioperative morbidity and decreased length of hospital stay. VATS is most successful for peripheral lesions and some central lesions in the lower lobe, and it is the surgical method of choice for diagnosis and resection of pulmonary nodules. If the nodules are too small or located too deeply to be detected thoracoscopically, preoperative CT-guided placement of a pulmonary nodule-marker system like methylene blue or wires is a safe and accurate method of localizing pulmonary nodules at thoracoscopy.

Much of the information on which guidelines are based for management of small nodules is derived from lung cancer screening. Based on a retrospective review of 2,897 baseline screening scans, initial recommendations for noncalcified nodules measuring <5 mm were to have a follow-up scan in 1 year. Management recommendations for small nodules were revised by the Fleischner Society in 2005, using separate algorithms for high- and low-risk patients. Subsequently, The American College of Chest Physicians published a set of 29 recommendations for the evaluation and management of small nodules, which stress inclusion of patient preference in management decisions.

Summary

- In view of the variety of diagnostic tests available and the variable accuracy of the different diagnostic techniques such as FDG-PET and

TNB, no single algorithm for workup is generally accepted.
- Practices vary from institution to institution, likely because of the varying prevalence of lung disease in different parts of the country, varying skill levels of operators, and varying availability of equipment.

Abbreviations

- CT, computed tomography
- FDG-PET, fluorodeoxyglucose-positron emission tomography
- HRCT, high-resolution computed tomography
- MRI, magnetic resonance imaging

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
	<0.1 mSv	<0.03 mSv
	0.1-1 mSv	0.03-0.3 mSv
	1-10 mSv	0.3-3 mSv
	10-30 mSv	3-10 mSv
	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Solitary pulmonary nodule
Lung cancer

Guideline Category

Diagnosis

Evaluation

Clinical Specialty

Oncology

Pulmonary Medicine

Radiology

Thoracic Surgery

Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physicians

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of radiologic examinations for patients with a solitary pulmonary nodule

Target Population

Patients with a solitary pulmonary nodule

Interventions and Practices Considered

1. Computed tomography (CT) chest
    - Without contrast
    - With contrast
    - Without and with contrast
2. Transthoracic needle biopsy
3. Fluorodeoxyglucose-positron emission tomography (FDG-PET)/CT whole body
4. Watchful waiting with CT follow-up
5. Magnetic resonance imaging (MRI) chest
    - Without contrast
    - Without and with contrast

Major Outcomes Considered

Utility of radiologic exam procedures in differential diagnosis

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 5 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

Number of Source Documents

The total number of source documents identified as the result of the literature search is not known.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Strength of Evidence Key

Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.

Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.

Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.

Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence for all articles included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member forms his/her own opinion based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Modified Delphi Technique

The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distributes surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The ratings are a scale between 1 and 9, which is further divided into three categories: 1, 2, or 3 is defined as "usually not appropriate"; 4, 5, or 6 is defined as "may be appropriate"; and 7, 8, or 9 is defined as "usually appropriate." Each panel member assigns one rating for each procedure per survey round. The surveys are collected and the results are tabulated, de-identified and redistributed after each round. A maximum of three rounds are conducted. The modified Delphi technique enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive bias from fellow panelists in a simple, standardized and economical process.

Consensus among the panel members must be achieved to determine the final rating for each procedure. Consensus is defined as eighty percent (80%) agreement within a rating category. The final rating is determined by the median of all the ratings once consensus has been reached. Up to three rating rounds are conducted to achieve consensus.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is accepted as the panel's consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is circulated, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current literature and expert panel consensus.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Selection of appropriate radiologic imaging procedures for evaluation of patients with a solitary pulmonary nodule

Potential Harms

- Positron emission tomography (PET) may give false-positive results in patients with active infections and inflammatory diseases.
- Recent reports suggest that the number of specific benign diagnoses can be increased using core needles, although this occurs at the cost of increasing complication rates when large-caliber needles are used.

Relative Radiation Level (RRL)

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the American College of Radiology (ACR) Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

Qualifying Statements

Qualifying Statements

The American College of Radiology (ACR) committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

Living with Illness

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Kanne JP, Jensen LE, Mohammed TH, Kirsch J, Amorosa JK, Brown K, Chung JH, Dyer DS, Ginsburg ME, Heitkamp DE, Kazerooni EA, Ketai LH, Parker JA, Ravenel JG, Saleh AG, Shah RD, Expert Panel on Thoracic Imaging. ACR Appropriateness CriteriaÂ® radiographically detected solitary pulmonary nodule. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 6 p. [39 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

1995 (revised 2012)

Guideline Developer(s)

American College of Radiology - Medical Specialty Society

Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Thoracic Imaging

Composition of Group That Authored the Guideline

Panel Members: Jeffrey P. Kanne, MD (*Principal Author*); Leif E. Jensen, MD, MPH (*Research Author*); Tan-Lucien H. Mohammed, MD (*Panel Chair*); Jacobo Kirsch, MD (*Panel Vice-chair*); Judith K. Amorosa, MD; Kathleen Brown, MD; Jonathan H. Chung, MD; Debra Sue Dyer, MD; Mark E. Ginsburg, MD; Darel E. Heitkamp, MD; Ella A. Kazerooni, MD; Loren H. Ketai, MD; J. Anthony Parker, MD, PhD; James G. Ravenel, MD; Anthony G. Saleh, MD; Rakesh D. Shah, MD

Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

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Guideline Availability

Electronic copies: Available from the American College of Radiology (ACR) Web site .

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site .
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in Portable Document Format (PDF) from the ACR Web site .
- ACR Appropriateness Criteria®. Evidence table development – diagnostic studies. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in PDF from the ACR Web site .
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the ACR Web site .
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in PDF from the ACR Web site .
- ACR Appropriateness Criteria® radiographically detected solitary pulmonary nodule. Evidence table. Reston (VA): American College of Radiology; 2012. 20 p. Electronic copies: Available from the ACR Web site .

Patient Resources

None available

NGC Status

This summary was completed by ECRI on March 25, 1999. The information was verified by the guideline developer on September 9, 1999. The summary was updated on February 12, 2002. The information was verified again by the guideline developer on March 25, 2002. This NGC summary was updated by ECRI on January 4, 2006. The updated information was verified by the guideline developer on January 19, 2006. This NGC summary was updated by ECRI Institute on July 23, 2009. This summary was updated by ECRI Institute on November 9, 2011 following the U.S. Food and Drug Administration advisory on Methylene Blue. This summary was updated by ECRI Institute on August 31, 2012.

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